(12) UK Patent Application (19) GB (11) 2 079 956 A

(21) Application No 8120081
(22) Date of filing 30 Jun 1981
(30) Priority data
(31) 3024660
(32) 30 Jun 1980
(33) Fed. Rep. of Germany (DE)
(43) Application published
27 Jan 1982
(51) INT CL³
G01F 13/00
(52) Domestic classification
G1R 4E1 CT
(56) Documents cited
GB 1305895
GB 1276717
GB 1130691
(58) Field of search
B8N
G1N
G1R
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(54) Method and apparatus for measuring total milk flow

(57) In a method and apparatus for measuring quantities of milk, the quantity of milk flowing from a first container (3), into a second container (4), in a unit of time, is determined, and the time for which the milk flows is measured. The apparatus has a duct (8) connecting the first and second containers (3, 4) and having a measuring flow path (13) giving a predetermined flow rate, and a flow sensor connected to a means for producing a time-dependent signal, thereby to determine the period of time for which milk is flowing through the measuring flow path.

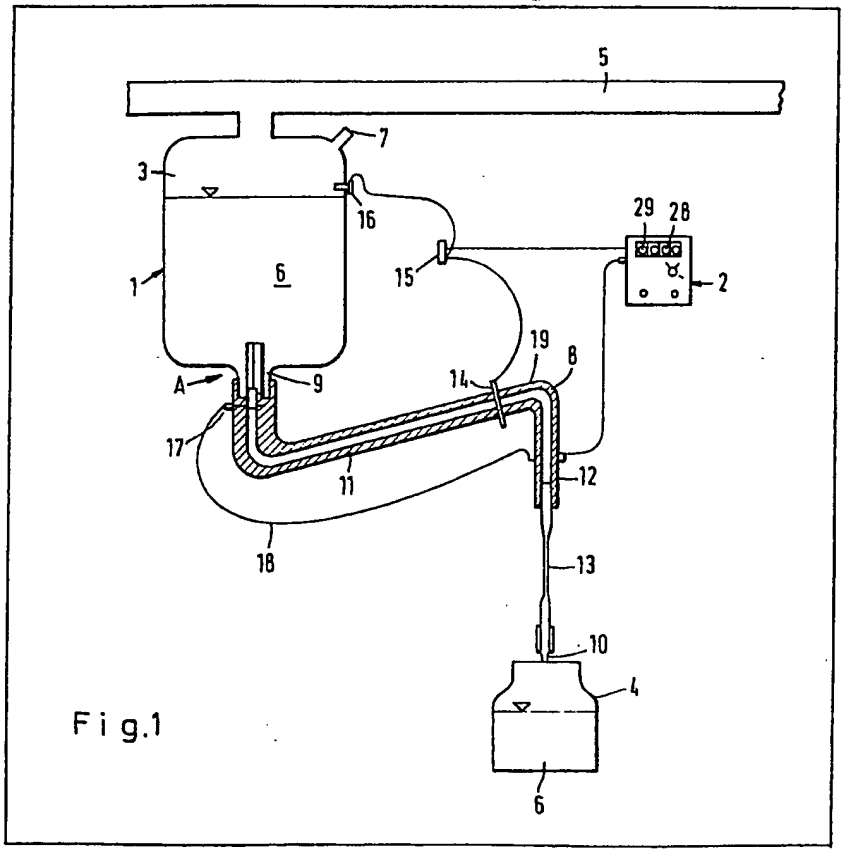

Fig.1

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Fig.1

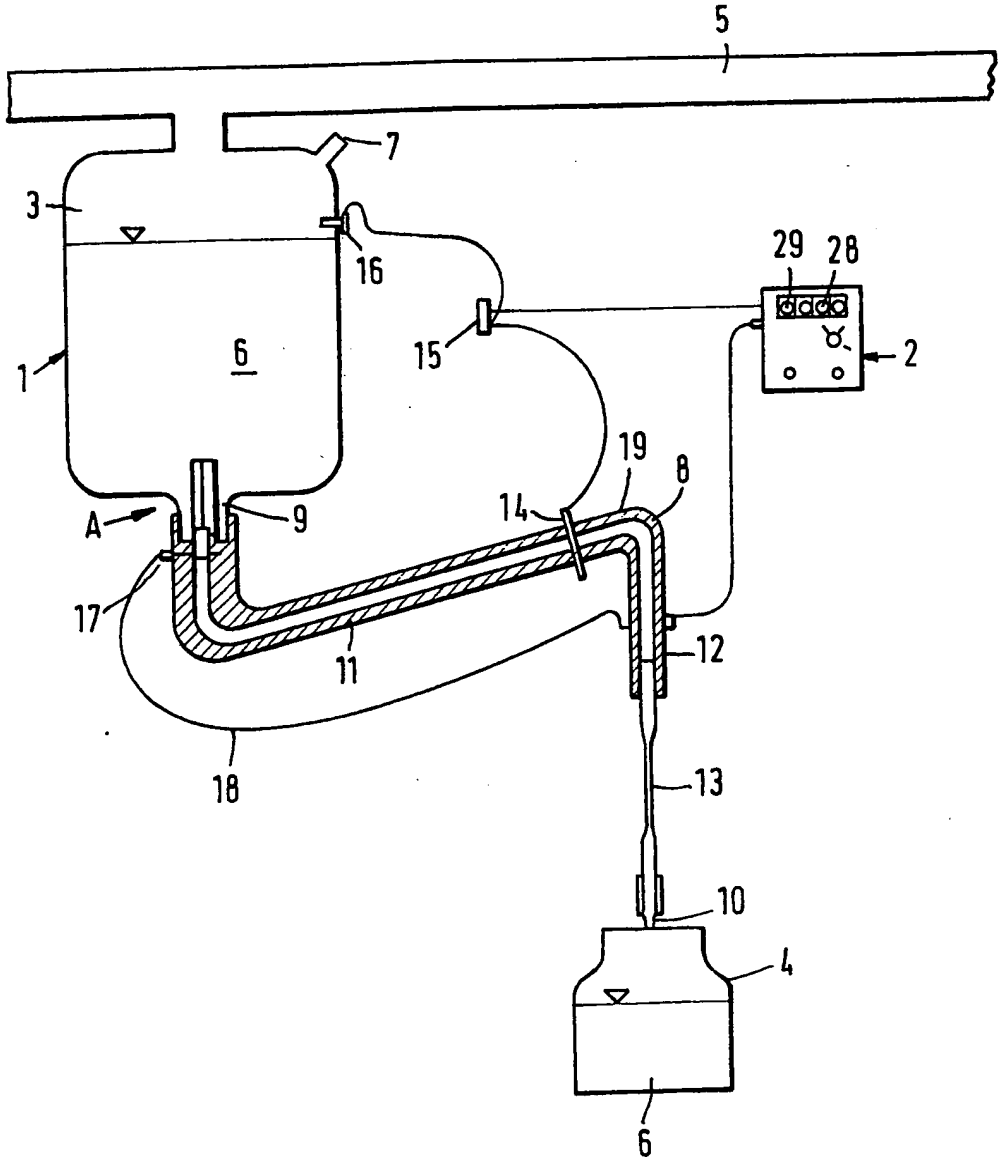

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Fig.2

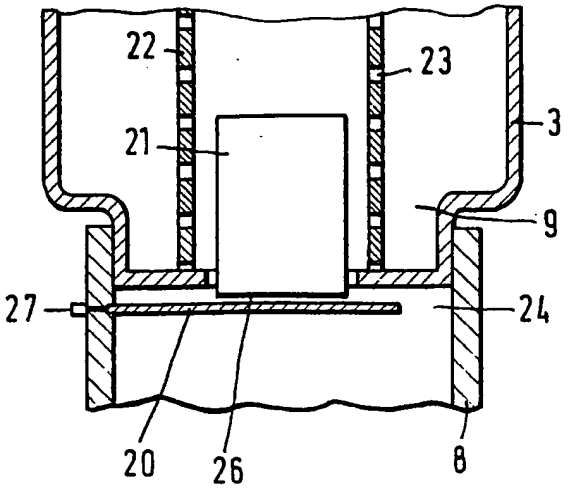
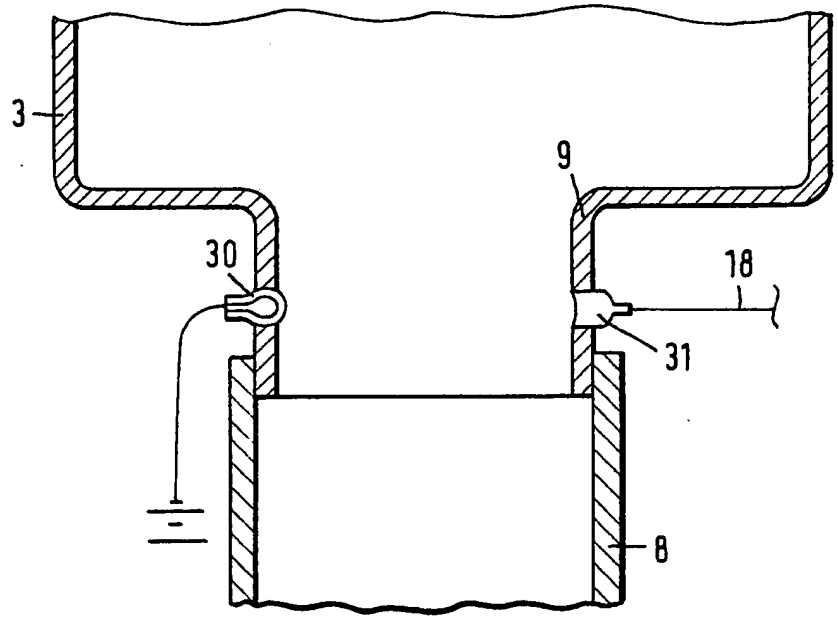


Fig.3



SPECIFICATION

Method and apparatus for measuring quantities of milk

The invention relates to a method of and apparatus for measuring quantities of milk which accumulate in a first milk vessel and which flow therefrom through a milk tube into a second milk vessel.

Apparatus for measuring quantities of milk have been previously proposed, some of which operate discontinuously while others operate continuously. Discontinuously operating apparatus for measuring quantities of milk determine for example the weight or the volume of a given quantity of milk. Corresponding conversion operations for the purposes of establishing the presence of a given amount of milk, as desired, are necessary.

It is desirable to be able to make continuous measurements in respect of quantities of milk, in particular in connection with mechanical milking processes. As it is precisely when using tube milking machines that milk is produced in a continuous flow, interrupting that flow for the purposes of detecting a given amount of milk involves additional work which has the effect of reducing productivity. In addition, it is desirable to be able to establish the amount of milk produced by individual cows, in order to be able to draw conclusions concerning the apportionment of fodder, the condition of health and the productivity of a given cow. The aim is to be able to establish the amount of milk which is milked from a given cow, as rapidly as possible, as, particularly when using milking stands, the milking station is to be occupied by a following cow, directly after milking of a given cow has been concluded.

For the purposes of continuously measuring quantities of milk, measuring apparatus have been recommended, of which some are very inaccurate in operation, while others require a considerable amount of and expenditure on apparatus. The apparatus which operate with a low degree of accuracy do not provide for measuring a precise flow of milk. As a mixed flow of milk and air is generally produced particularly when using mechanical milking apparatus, mixed amounts of milk and air are measured by these measuring apparatus. Conversion to the actual amount of milk which has been milked is effected on the basis of empirical values which of course give only a highly inaccurate view of the amount of milk actually produced.

Usually, the milk is measured in a recorder, as is used as a milk separating means in most milking equipment. For this purpose, the transparent wall of the recorder has filling markings which indicate the association as between given levels of filling and the corresponding amounts of milk. In principle, this method of measuring quantities of milk is a simple method, but it no longer satisfies modern claims in regard to measuring quantities of milk. It is excessively inaccurate and depends for example on the recorder being hung up in a properly aligned and straight position. As soon as the recorder is tilted out of a vertical position, the measurement operation suffers from errors which can possibly be of fairly large magnitude. In addition, errors in measurement occur in reading off the values, as it is not possible to exclude shifts due to parallax. Finally, the measurement results can only be used by being introduced again for example into a computing apparatus. There are no pulses which are suitable for further processing of the measurement result.

According to one aspect of the invention there is provided a method of measuring quantities of milk which accumulate in a first milk vessel and flow therefrom into a second milk vessel, comprising determining the quantity of milk flowing in a unit of time and measuring the time for which the milk flows.

Such a method can ensure that quantities of milk can be accurately detected, and the detection operation can be carried out economically.

An operation of measuring quantities of milk, which is performed in accordance with the method of the invention can have the advantage that the amount of milk flowing can be detected and measured in a simple manner while the milk is flowing from an intermediate collecting vessel to a collecting container. This is essentially effected by measuring through-flow times in which the milk flows through a conduit which connects the two containers and the flow section of which permits a given flow of milk per unit of time. The results of the time measurement operation can be recorded as a display in terms of quantities of milk. On the basis of the individual quantity displays, the amounts of milk produced by a number of individual animals can be added, so that a general review of the total amount of milk produced can be achieved, at a relatively early stage. Precise measurement can also be achieved with small quantities of milk, so that precise measurement results can still be achieved, even with a low milk yield. These measurement results relate exclusively to the amount of milk milked, the air in the milk-air mixture which conveys the milk in the conduit system having been removed from the milk, the quantity of which is measured. Finally, by virtue of rapidly and accurately determining the amount of milk which is milked from a given cow, it is possible to apportion fodder to the animal, according to the respective requirement of that cow. For that reason, the method of the invention is particularly suitable for dairies which operate on the basis of the most recent findings in regard to keeping milk animals. As generally the measurement results are supplied by an electronic time measuring apparatus, it is possible to provide for automatic control of feeding of the animals, by means of such equipment. In extensively automated dairies, it is also possible for the entire process of keeping the animals to be rationalised by means of such measurement results.

The previously known apparatus and equipment for measuring quantities of milk operate inaccurately and do not produce pulses

which can be put to use for the purposes of determining and recording the results of operations of measuring quantities of milk. They have to be precisely adjusted in regard to their position. Any variations in position, which can occur under the rough working conditions of a cow stall, can in part result in serious errors in measurement.

According to another aspect of the invention there is provided apparatus for measuring quantities of milk which accumulate in a first milk vessel and which flow therefrom into a second milk vessel comprising a milk tube connecting the first and second vessels, a flow path of given flow section and flow sensor disposed in the milk tube, and a member for producing a time-dependent signal and controllingly connected to the flow sensor which detects a flow in the milk tube and whose starting pulse occurs at the beginning of the through-flow of the quantity of milk, and whose termination pulse occurs at the end of said through-flow.

The apparatus can be limited to a small number of components which have to be arranged in the flow of milk. The milk flows through them, so that they are easy to clean. There are no major residues of milk left in the apparatus. In addition, the apparatus can be easy to install at a subsequent time, and can therefore also be used in milking equipment which has already been installed. The apparatus can be easy to handle and simple to maintain.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:—

Figure 1 shows a diagrammatic view of apparatus according to said another aspect of the invention for measuring quantities of milk;

Figure 2 shows a view in cross-section through a container outlet, on an enlarged scale, of part of the apparatus indicated at A in Figure 1; and

Figure 3 shows a view in cross-section through a container outlet of a different kind.

Referring to Figure 1, apparatus for measuring quantities of milk comprises a measuring means 1 and registering or recording means 2, which are operationally connected together. The measuring means 1 is disposed between two milk vessels 3 and 4, one of which is set at a higher level than the other. The higher milk vessel 3 may be connected, to act as a milk trap or separator, to a milk conduit 5 from which milk 6 falls into the milk vessel 3, with air being extracted through an outlet 7. While initially a mixture of air and milk which is being conveyed in the milk conduit 5 passes into the milk vessel 3, after the air is extracted through the outlet 7, this arrangement ensures that milk from which air has been removed accumulates or collects in the lower part of the milk vessel 3.

The milk vessel 4 may be any desired milk collecting container in which the milk 6 is stored for example until required for further processing. Thus, the milk vessel 4 may be in the form of a cooled milk vat.

Extending between the two milk vessels 3 and 4 is a milk hose or tube 8 which communicates on the one hand with an outlet 9 in the lower part of the milk vessel 3, and on the other hand, with an inlet 10 in the upper part of the milk vessel 4. The inlet 10 may be arranged at any position on the milk vessel 4.

The milk tube 8 is laid in such a manner that, directly downstream of the outlet 9, it initially rises somewhat in a rising portion 11, the then falls towards the milk vessel 4, in a falling portion 12. Incorporated in the falling portion 12 is a flow path 13 which is of a given cross-section and which is of such a length that a smooth or quietened flow of milk will be formed in the flow path 13. Arranged in the rising portion 11 of the milk tube 8 is a shut-off means 14 which is generally disposed directly in the region of the transition of the rising portion 11 to the falling portion 12. The shut-off means 14 is connected to a switch 15 for controlling the shut-off means 14. In addition, the recording means 2 is coupled to the switch 15 in such a way that it can be set in operation at the same time as the shut-off means 14 is opened. Finally, also connected to the switch 15 is a valve 16 which vents the milk vessel 3 and which also opens at the same time as the shut-off means 14, to provide access for the ambient air into the milk vessel 3.

The recording means is essentially formed as a time measuring means which, after triggering by a pulse produced by the switch 15, begins to measure a period of time which elapses after it is triggered. Desirably, the time measuring means is in the form of a component which produces a time-dependent signal, for example, a frequency modulator. Depending on the frequency set, the frequency modulator produces signals which are counted by the recording means 2.

The recording means 2 is also connected to a measuring contact means 17 which is disposed at the outlet 9 of the milk vessel 3 and which can be for example in the form of a reed switch. The measuring contact means 17 passes switching pulses by way of a line 18 to the recording means 2, depending on whether a float 21 is floating on the milk or is in a position of actuating the reed switch.

The operation of measuring the amount of milk is effected by the shut-off member 14 firstly preventing milk from flowing through the milk tube 8. The milk which accumulates in the milk vessel 3 flows through the outlet 9 to the shut-off means 14 which prevents it from flowing on towards the milk vessel 4. After a sufficient amount of milk has accumulated in the milk vessel 3, the shut-off means 14 is opened by means of the switch 15 so that the milk 6 can issue through the flow path 13 towards the milk vessel 4. At the same time, the recording means 2 is set in operation in such a way that it measures the period of time which has elapsed since the switch 15 was actuated. During that period of time, a given amount of milk, per unit of time, flows through the path 13. As soon as the total quantity

of milk in the milk vessel 3 has passed out through the outlet 9, the measuring contact means 17 produces a switching pulse which stops the recording means 2. As moreover the rise in the milk tube 8 is of such a magnitude that the milk 6 can no longer flow over the highest point 19 in the milk tube 8 when the flow of milk at the outlet 9 is terminated, this arrangement ensures that the recording means 2 is also rendered inoperative, at the same time as the flow of milk in the region of the path 13 ceases.

The recording means 2 may be a computer which performs the multiplication operation, which is required for determining the amount of milk, namely, multiplying the detected units of time by the amount of milk which flows through the flow path 13 in each unit of time. This makes it possible for the amount of milk measured to be displayed directly by the recording means 2. Finally, it is also possible for the milk conduit 8 to be laid without the rising portion 11 on the one hand and the falling portion 12 on the other hand. In this case, the arrangement must be such that the shut-off means 14 is controlled at the same time as the recording means 2, by the measuring contact means 17. In that arrangement, the milk tube may be laid in such a way that the second milk vessel 4 is in any position relative to the first milk vessel 3. The milk tube 8 may be laid in a straight line or it may be curved, depending on the requirements of the local conditions involved. The only decisive consideration is that the flow path 13 is completely filled with milk at any moment during the measurement operation. This requirement can be fulfilled *inter alia* by the flow of milk in the milk tube 8 always being maintained with the same energy. That energy may be produced *inter alia* by a permanently uniform pressure drop between the first milk vessel 3 and the second milk vessel 4. In this arrangement, it is possible for the milk to be pressured out of the first milk vessel 3 into the second milk vessel 4 by means of an increased pressure, or for the milk to be sucked from the first milk vessel 3 into the second milk vessel 4, by means of a reduced pressure.

It is also necessary to make provision for monitoring the flow of milk at the beginning of the flow path 13, in such a way that the time measuring means is switched off as soon as the milk tube 8 is incompletely filled, at the beginning of the flow path 13.

Monitoring in respect of the flow of milk at the outlet 9 of the first milk vessel 3 may be effected by a reed contact means being installed in the outlet 9. The reed contact means 20 is actuated by the float 21 which floats in the first milk vessel 3 as long as there is milk in that vessel. In order to be able to control the movements of the float 21, a guide means in the form of a float cage 22 is provided in the milk vessel 3. The float cage 22 extends from the outlet 9 vertically into the milk vessel 3. It is provided with through openings 23 through which the milk can pass into the interior of the float cage 22. The inside diameter of the float cage is such that the float 21 is guided so closely, with a given clearance, that it precisely reproduces the degree to which the milk vessel 3 is filled with milk.

When the milk vessel 3 empties through the outlet 9, the float 21 moves down towards the reed switch 20. As soon as the milk vessel 3 is empty, the float 21 lies by way of a control edge 26 on the reed switch 20 so that the reed switch 20 passes a switching pulse to the recording means 2, by way of a terminal 27. The recording means 2 is then stopped.

The recording means 2 includes a time-dependent signal-producing component 28 which is switched on for the period of time which has elapsed since the switch 15 was actuated. The time measuring means may be in the form of a component which produces a time-dependent signal. The component 28 is desirably in the form of a frequency modulator in which the respective frequency desired can be set. Depending on the respective frequency setting, the frequency modulator transmits pulses to the recording means 2. This time measurement arrangement, with a variable time base, has the advantage that it can be adapted to the particular requirements of the quantity measuring operation. In this procedure, either the time required for the expected total amount is estimated, as the reference point, and the frequency to be established for the individual measurement operation is selected in proportion to that estimated time. However, it is also possible for the expected amount of milk to be used directly as a basis for the reference point, and for the frequency to be set in accordance with that expected amount. In addition, it is possible for the frequency to be kept constant over the entire period of time of measuring the amount of milk filling a vessel. In that case, a mean value is measured in respect of the total quantity filling the container, as there may be a number of factors which are responsible for the milk flowing through the measuring flow path being different, at the beginning of the measurement operation, from the milk flowing through the measuring path at the end of the measuring operation. If it is considered for example that the milk flows out of the first measuring vessel 4 under its own weight, then the rate of flow at the beginning of the measurement operation is higher than at the end of the measurement operation, because of the reducing pressure of the head of milk. A similar situation arises in regard to the action of other forces on the head of milk. Those forces may also act on the head of milk in a discontinuous fashion throughout the entire measurement operation. In all those cases, involving a variable amount of milk flowing through the flow path 13, a mean value is generally measured, in respect of the quantity of milk flowing in each unit of time, by presetting a given frequency which is constant over the entire measurement period. In this way, the result of the entire measuring operation is of sufficient accuracy for the required purpose.

In exceptional cases however, the frequency may also be adapted to the quantity of milk passing through the measuring flow path 13 at each moment. Such adaptation is effected by the frequency being established in dependence on the forces which act on the milk on flowing out of the milk vessel 3. Such forces are dependent on the one hand on the head of milk which is present in the milk vessel 3 and on the other hand on the other forces acting on the milk. These include primarily the influences of pressure acting on the milk in the vessel. For example, the air may be sucked out of the milk vessel, or the surface of the milk in the milk vessel 3 may be subjected to the influence of a greater or lesser reduction in pressure.

Finally, it is possible for the measuring path 13 on the one hand and the frequency of the component 28 on the other hand to be adapted to each other in such a way that the milk flowing through the flow path 13 in a unit of time is associated with a given basic frequency. In this way, the time for which the milk actually flows represents a multiple of that unit of time so that it is only necessary to carry out a multiplication operation using small multipliers. In this form of the measuring operation the important consideration is also to be able to estimate from the outset, what quantity of milk will flow from the milk vessel 3 into the milk vessel 4. The frequency on which the measuring operation is based is then selected in accordance with that estimated amount of milk.

The component 28 which produces the time-dependent signals may be integrated in a simple computer which multiplies the pulses counted after actuation of the switch 15, directly by the amount of milk which flowed through the flow path 13 in each unit of time. In this case, a value which directly corresponds to the measured quantity of milk will be read off on a display means 29. The value calculated by the computer may also be used for directly controlling further operations. For example, it is possible for the value computed by the recording means 2 to be used to actuate control means for controlling the allocation of fodder. The correctness of the measurement operation depends on the flow path 13 always having milk flowing through the entire flow cross-section thereof, for the periof of time for which the component 28 is switched on. In addition, an important consideration is for the beginning and the end of the time measuring operation to be synchronised with the beginning and the end of the flow of milk in the flow path 13. The shut-off means 14 is actuated in such a way that the time measurement operation begins at the moment at which milk first begins to flow through the flow path 13. Time measurement must be concluded when no further milk is flowing through the flow path 13.

The accuracy of the time measurement operation therefore depends on monitoring the flow of milk in the milk tube 8. Such a monitoring action may be advantageously carried out by means of a flow monitoring means. The flow monitoring means produces pulses which are transmitted directly to the recording means 2, in order to control the recording means, as required, in such a way that it stops the time measuring means 28 or sets it in operation. The flow monitoring means may be arranged for example in the outlet 9 of the first milk vessel 3. In this way, the flow monitoring means detects whether sufficient milk is passing from the outlet 9 into the milk tube 8, in order to fill the flow path 13. However, when using an arrangement as described with reference to Figure 1, it has been found particularly desirable for the flow monitoring means to be arranged in the falling portion 12, directly before the milk passes into the flow path 13. It then produces a control pulse when the amount of milk passing into the rising portion 11 of the milk hose is no longer sufficient to push the column of milk out of the rising portion 11 into the falling portion 12. The component 28 is switched off at that moment.

CLAIMS

1. A method of measuring quantities of milk which accumulate in a first milk vessel and flow therefrom into a second milk vessel, comprising determining the quantity of milk flowing in a unit of time and measuring the time for which the milk flows.

2. A method according to claim 1, in which the time measurement operation is performed with a variable time base.

3. A method according to claim 1 or claim 2, in which, for the purposes of the time measurement operation, time-proportional signals are produced, and the number of signals is counted.

4. A method according to claim 3, in which the time-proportional signals are in the form of a frequency.

5. A method according to claim 4, in which the frequency is selected in accordance with the probable time that is required for the milk accumulated in the first milk vessel to flow out into the second milk vessel taking into account the quantity of milk flowing in said unit of time.

6. A method according to claim 4, in which the frequency is set in accordance with the quantity of milk to be measured, and a switching signal is produced for each unit of quantity.

7. A method according to any one of claims 1 to 6, in which the quantity of milk flowing in said unit of time is established by a flow path having a given flow section.

8. A method according to any one of claims 1 to 7, in which the energy producing the through-flow is kept constant during emptying of the first milk vessel.

9. A method according to any one of claims 1 to 7, in which the energy producing the through-flow is varied during emptying of the first milk vessel.

10. A method according to claim 9, in which the energy producing the through-flow is adapted to the respective degree of filling of the first milk

vessel.

11. A method according to any one of claims 8 to 10, in which the frequency is varied in accordance with the energy producing the through-flow.

12. A method according to any one of claims 8 to 10, in which the frequency is kept at a constant value over the time required for emptying of the first milk vessel.

13. A method according to claim 3, in which the start of the time-proportional signals and the commencement of the flow operation are synchronised with each other in respect of time, and a first permanent display appears at a moment at which the entire quantity of milk to be measured has run out of the first milk vessel.

14. A method according to claim 13, in which the time-proportional signals are recorded in the form of a quantity display.

15. A methods according to claim 3, in which the milk is dammed up at a flow impediment before the measurement operation begins, and the start of the time-proportional signals is triggered simultaneously with removal of the flow impediment.

16. A method according to any one of claims 1 to 15, in which the measurement operation is terminated at the end of the through-flow of the quantity of milk, with a switching signal, and the switching signal is actuated by a signal generator which is disposed in the first milk vessel and which is triggered after a defined emptying of the first milk vessel.

17. A method according to any one of claims 1 to 16, in which the milk flows through the measuring flow path in free fall.

18. Apparatus for measuring quantities of milk which accumulate in a first milk vessel and which flow therefrom into a second milk vessel comprising a milk tube connecting the first and second vessels, a flow path of given flow section and a flow sensor disposed in the milk tube, and a member for producing a time-dependent signal and controllingly connected to the flow sensor which detects a flow in the milk tube and whose starting pulse occurs at the beginning of the through-flow of the quantity of milk, and whose termination pulse occurs at the end of said through-flow.

19. Apparatus according to claim 18, including air suction means provided on the second vessel.

20. Apparatus according to claim 18 or claim 19, including a controllable shut-off means provided between the flow path and the first milk vessel, which shut-off means is coupled to said member which can be triggered at the moment of opening of the shut-off means and which produces a time-dependent signal, and, provided in the first milk vessel, a sensor which indicates complete emptying thereof and which is connected to said member for switching it off.

21. Apparatus according to any one of claims 18 to 20, in which the flow path is disposed in any part of the milk tube.

22. Apparatus according to any one of claims 18 to 20, in which the flow path which determines the through-flow of milk is disposed in a part of the milk tube which falls towards the second milk vessel.

23. Apparatus according to claim 22, in which the flow sensor is disposed in a falling part of the milk tube.

24. Apparatus according to any one of claims 18 to 23, in which the measuring flow path has an inlet and an outlet end, which smooth the flow of milk on passing therethrough.

25. Apparatus according to any one of claims 18 to 24, in which the measuring flow path is of a length which smoothes the milk on passing therethrough.

26. Apparatus according to claim 24, including measuring contact means for indicating the through-flow of milk and provided at the outlet of the first vessel.

27. Apparatus according to claim 26, in which the measuring contact means is in the form of a filling level display means.

28. Apparatus according to claim 26, in which the measuring contact means is in the form of a reed switch which is actuated by a float in its lowermost position.

29. Apparatus according to claim 28, in which the float is guided in a guide means which extends from the outlet into the first milk vessel.

30. Apparatus according to claim 26, in which the measuring contact means is in the form of a flow monitoring means.

31. Apparatus according to claim 20, including a switch for jointly triggering the shut-off means on the one hand and said member which produces a time-dependent signal on the other hand.

32. Apparatus according to claim 31, including a valve which vents the first milk vessel at the moment of triggering of said member for producing a time-dependent signal and connected to the switch.

33. Apparatus according to claim 20, in which there is a steady head in the milk tube from the first milk vessel to the second milk vessel, and the shut-off means is in an open position at the beginning of the time measurement operation and in a closed condition at the end of total filling of the milk tube.

34. Apparatus according to any one of claims 18 to 21, in which, with the milk tube being laid in any manner, there is a pressure difference between the first and the second milk vessels, which provides for constant conveyance of the milk.

35. Apparatus according to any one of claims 18 to 34, in which the means for recording the time-dependent signals is calibrated in units of volume.

36. Apparatus according to any one of claims 18 to 34, in which the means for recording the time-dependent signals is calibrated in units of quantity.

37. A method of measuring quantities of milk

as claimed in claim 1 and substantially as hereinbefore described.

38. Apparatus for measuring quantities of milk substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1982. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.